A Survey of Total Quality Management Implementation in Manufacturing Industry

by

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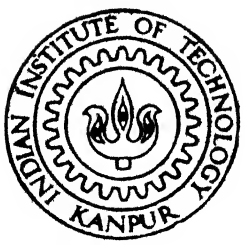

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A SURVEY OF TOTAL QUALITY MANAGEMENT IMPLEMENTATION IN MANUFACTURING INDUSTRY

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CERTIFICATE

It is certified that the work contained in this thesis entitled "**A Survey Of Total Quality Management Implementation In Manufacturing Industry** " by **Hemant Kumar Rathore,** has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

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ABSTRACT

Total Quality Management (TQM) has become, according to one source, 'as pervasive a part of business thinking as quarterly financial results'. In effort to stay close to the market, companies are adopting TQM. Extent of various TQM aspects and effects of organizational context on TQM practices are investigated using data collected from 82 respondents and 15 manufacturing companies A previously reported instrument with some modifications was used to measure perceptions of eight TQM practices including top management commitment, customer focus, benchmarking, supplier quality management, SPC usage, internal quality information, employee involvement and training. Results indicate that extent of TQM aspects vary with the environs in which a firm operates. Some findings are consistent with established TQM norms and others provide an understanding of the neglected domains of TQM. This study reveals the overall scenario from manufacturing-industry' s perspective. It is also observed that some specific TQM approaches have found their wide dissemination in a particular segment of industry.

CONTENTS

ABBREVIATIONS

ABB	Asian Brown Bowery
ANOVA	Analysis Of Variance
CII	Confederation Of Indian Industries
GM	General Manager
HR	Human Resources
K-W	Kruskal Wallies
PDCA	Plan-Do-Check-Action
QA	Quality Assurance
QC	Quality Control
R&D	Research and Development
SPC	Statistical Process Control
TQM	Total Quality management
UJSE	Union of Japanese Scientists and Engineers

1

INTRODUCTION

1.1 Rationale of the Study

Total Quality Management(TQM)'s origin can be traced back to 1944, when Japan's industry and economy was shattered during the second world-war, and the Union of Japanese Scientists and Engineers(UJSE) formed a committee of scholars, engineers and government officials devoted to improving Japanese productivity, and enhancing their post-war quality of life. Japan invited two quality gurus - Dr. Deming and Dr. Juran - to teach the importance of quality to Japanese industrialists when they were trying to rebuild after the war. Influenced by Deming and Juran, the committee developed a course on statistical quality control for Japanese engineers followed by extensive statistical training and widespread dissemination of Deming's philosophy which taught them: the value of PDCA (Plan - Do-Check-Act) cycle, the managerial significance of the distinction between special and system causes of variation, and to view an organization as a system (an interdependent system of stake holders). The Japanese listened to these experts with all attention and put their teaching into practice religiously. The quality and consequently the competitiveness of Japanese industry started improving steadily. Soon they caught up with the western world - USA and Europe - and started excelling them. In 1970s, when the U. S. automobile industry was hit by the competition from Japanese

models in its own market, the western world realised the progress made by Japan due to her stress on quality.

American firms began to take serious note of TQM around 1980 ,when analysts and policy leaders decried traditional managerial practices such as elitist leadership, short term thinking, financial orientation, lack of innovation, declining productivity, and adversarial supplier relationships. Some high profile American firms - such as Ford, Xerox, and Motorola - were easily convinced, having already lost market to more efficient, higher quality Japanese producers. These firms under the guidance of Deming and other quality consultants, benchmarked Japanese practices and were among the first TQM adopters Soon after, others joined in the march towards TQM.

In 1991 when doors of the economy were opened and MNCs were encouraged to operate in Indian markets, majority of Indian manufacturers and producers and providers of goods and services were not aware of the terms like customer satisfaction and quality control. As one industrial puts it "Can you believe it, they (Indian Consumers) now have the nerves to actually demand good quality product in our products?". Till the days of closed economy and start of the era of deregulation, average Indian manufacturers were taking customers for granted and remain ignorant of the altered situation in the mistaken belief that the quality control is a cost enhancing, production-hampering nuisance fetching no bonuses in the domestic market. Now, that a customer has a choice and is demanding his penny's worth of quality, combined with aggressive strategies of foreign brands, Indian brands slowly started to take the road out of market. As a result, a welcome sense of urgency about issues of quality was developed.

What Japanese industry did in 1950s and 1960s, what the western world did in the 1980s provide a guidance as to what we in India need to do. Many enlightened firms started to

adopt TQM culture. TQM is an integrated manufacturing philosophy and set of practices that emphasizes, among other things, continuos improvement, meeting customer requirements, reducing rework, long range thinking , increased employee involvement and teamwork, process redesign, competitive benchmarking, team based problem solving, constant measurements of results, and closer relationships with suppliers. Its adherents claim that TQM in any organization - manufacturing, service, nonprofit or government, can be implemented and that it generates improved products and services at reduced cost, more satisfied customers and employees and improves bottom line financial performance.

The TQM literature is replete with practitioner-oriented "do-everything-right" articles and case studies. The TQM field has yet to develop a theoretical and empirical base(Ahire,1995). Only recently empirical investigations have begun to examine TQM implementation and this study is an effort towards this objective. This research aims to study the implementation of TQM in Indian manufacturing industry, because total quality management basically has emerged from manufacturing and remains widely disseminated among manufacturers. An attempt has been made to know the extent of implementation of TQM aspects. Each organization operates with different types of people, in different kinds of environments, and has different kinds of sophistication and maturity. So there is no universal answer on the approach to TQM implementation. This study also tries to explore the effects which different organizational variables have on the implementation of TQM practices.

1.2 The Research Objectives

Following are the broad research objectives:

- To examine the extent of TQM aspects as are practised in Indian manufacturing industry, and
- to understand how the contextual factors affect the various TQM aspects in manufacturing industry.

1.3 Plan Of Thesis

The first chapter has discussed the rational of study, research objectives and plan of thesis. The second chapter reviews the relevant literature compiled from diverse sources and focus areas for the research. The third chapter rebuilds the research framework. This also gives an idea on research methodology, data collection procedure and choice of statistical methods for dat analysis. The penultimate chapter presents the data analysis. Finally, chapter five gives research findings, limitations of study and scope for further research work.

2

Literature Review

2.1 Introduction

To be consistent with stated research objective in previous chapter, literature review is carried out in the following two sections. Firstly, literature is surveyed about the TQM strategies and practices, followed by a discussion on various contextual factors in relation to an organization.

2.2 TQM Constructs

Total quality management (TQM) is an approach to improving the effectiveness and flexibility of business as whole. It is essentially a way of organizing and involving the whole organization; every department, every activity, every single person at every level. For an organization to be truly effective, each part of it must work properly together, recognizing that every person and every activity affects, and in turn is affected by , others (Oakland,1989).

TQM is a method for riding people's lives of wasted effort by involving every one in the processes of improvement; improving the effectiveness of work so that results are achieved in less time. The methods and techniques used in TQM can be applied throughout the organization. They are equally useful to finance, sales, marketing, distribution, development, manufacturing, public relations, personnel, to every one of a

companies' activities. Eight TQM constructs are identified from the literature reviewed. Each is discussed in detail in following sections

2.2.1 Top Management Commitment

To achieve a TQM based competitive organization, the issue of leadership has to be at the heart of any drive, desire or determination to compete on quality ground (*Zairi,*1990) Views of quality gurus say about this extremely important factor for a total quality movement (Oakland,1989).

- ***Crosby*** -responsible for quality
- ***Conway*** -bottleneck is located at top of bottle.
- ***Dr. Deming*** -responsible for 94% of quality problems.
- ***Juran*** -less than 20% of quality problems are due to workers.

In sum, all assign the responsibility to drive an organization towards the total quality to its committed leadership. According to them, TQM must be truly company wide and it must start at the top with CEO, or equivalent, and senior management, who must demonstrate that they are serious about quality . Middle management play an important role to this commitment by explaining TQM principles to the people for whom they are responsible, within each and every department of the company at all levels, starting at the top, basic changes of the attitudes will be required to operate TQM.

Top management is responsible for initiating and supporting a vision towards TQM. Executive actions speak louder than words. The role of the leaders is particularly important in TQM organizations because the role of the middle managers has changed. Their traditional role as the authoritarian head has changed. Empowering supervisors and middle management for building their teams give them a clearly defined role to play in development of TQM program. While an intellectual understanding of quality provides a

basis for TQM, it is clearly the planting of the seed. The understanding must be translated into commitment, policies, plans and actions for TQM to germinate (Oakland,1989)

2.2.2 Customer Focus

The main objective of quality improvement is to place customer's needs and requirements at the forefront of a company's quality improvement strategy (Newall, 1991). Because of increasing customer awareness and expectations for improved products and services, customer focus has now become a key element of product quality. An organization must recognize that the purpose of all work and all efforts to make improvements is to serve better the customers. This means that it must always know how well its outputs are performing through measurements and feedback. Various techniques such as quality function deployment, customer surveys and multiattribute modelling is used for measurement and feedback purpose.

Another aspect of customer focus is aimed at determining the needs of a customer before he or she becomes aware of that. Product characteristics are categorized as "must be" and attractive". This "attractive" characterises are the latent or hidden requirements, meaning that if they are not present, customer is not aware they are missing. Their absence does not detract from level of customer satisfaction, however, if they are present satisfaction increases dramatically (Juran, 1989). IBM' Polaroid service, illuminated telephone dials for dark room users from Bell's laboratory is one such example. Also, many quality awards such as Malcolm Balridge and CII-EXIM AWARD have assigned a high weightage to customer focus of the applicant organization (Rao, 1996).

2.2.3 Supplier Quality Management

Crosby (Oakland,1989) states that the supplier should be treated as an extension of the business. In his view, at least half of the quality problems are associated with

purchased materials caused by not clearly stating what the requirements are Most of the faults concerning purchased materials are the faults of the purchaser. For, supplier is not provided with clear and adequate information and requirements, he doesn't know precisely what to manufacture. Inspection increases cost for both, supplier as well as purchaser. This can be avoided by improving supplier' performance by securing real commitment from senior management of supplier organization. Process of improvement is complex and includes various measures and steps to be taken from both sides Inspection through acceptance sampling etc. can be eliminated, if companies deal with suppliers under statistical control. It is just as vital to achieve statistical control of quality from your vendors as it is to have internally (Oakland,1989). Use of statistical methods leads to predictability, measures of improvement, and a dialogue in 'statistical language' between purchaser and supplier. Investment of time, effort and special skills is required to help supplier improve, and extension of team approach to them is necessary.

Besides suppliers may be brought together to share the realization of importance of their performance in quality chain. (Oakland,1989) A supplier of goods and services who have received such attention , education and training from buyer, understands the role its inputs play in final products and services. This leads to elimination of potential problems and helps in creating a "win-win" situation. Many customers examine their suppliers' quality management systems themselves, operating a second party assessment scheme. Inevitably this involves high costs and duplication of activities, for both customer and supplier. Visits and dialogues across the customer / supplier interface are a necessity if the true requirements are to be met and for future growth of the whole business chain.

2.2.4 Benchmarking

Is the concept to set quality goals based on realities rather than on empirical judgement. It is a systematic process for measuring products, services and practices against external partners to achieve improved performance. Xerox views benchmarking as structured approach for looking outside the organization. Benchmarking is viewed as a part of discovery process by which they learn to work better. In this sense Deming's call for developing system of "profound knowledge"[1] is supported. Benchmarking has evolved over the years and broadened its scope from improving existing products and processes to business strategies and competitive tactics The commonly used methods in early times for benchmarking process include, site visits and reverse engineering. In recent times, Benchmarking practices can be classified in two categories- competitive and functional. When benchmarking effort enables a process to become as good as of competitor's then it is called competitive benchmarking, if goals are set to become superior to the competition and activities look at companies outside the industry which perform same function, then it is functional benchmarking.

From the experiences of companies involve in benchmarking have recognized the following advantages of benchmarking(Rao,1996):

- Achievement of challenging goals is possible by setting targets on the basis of hard data.

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[1] Dr. Deming's "profound knowledge" system include following principles:

1. Appreciate a system- Realization that a system is a collection of interacting components. Emphasis is on optimizing the whole system.
2. Theory of variation- Reduce system causes of variations and inherent variations.
3. Knowledge is not information- But it is an ability to predict the future with risk of failing and explain past events without fail.
4. Knowledge of Psychology- Helps managers to understand the correct composition of intrinsic and extrinsic motivation.

- Cycle time and cost of implementing the process is reduced. It has been noted that development time for on company was six weeks and costs were slightly more than $5000, while the company originally involved had taken four years to develop the system at a cost of more than $500,000.

In sum, it can be said that "benchmarking" is an essential tool of TQM.

2.2.5 SPC usage

A process is the transformation of a set of inputs, which can include actions, methods, and operations, into desired outputs, in the form of products, information, services. In each area or function of an organization there will be many processes taking place. As Deming puts it, "quality and productivity increase as variability decreases and, because things vary, that is why statistical methods of quality control must be used Conway advocates strongly the use of statistical methods to achieve waste reduction, on the grounds that attempts to improve quality and productivity with generalities always fail. He further distinguishes between simple and sophisticated techniques or tools. Basic tools of SPC which quality guru Ishikawa has called the "Seven tools" are: flow charts, fishbone charts, histogram, pareto charts, run charts, scatter diagrams and cause effect charts, which can be used to solve 85% of a company's problems. The more advanced techniques include Taguchi methods and process capability studies used for improvement of process.

SPC methods, backed by management commitment, provide objective means of controlling quality in any transformation process. SPC is not only a tool kit, but it is a strategy for reducing variability, the cause of most quality problems: variation in products, in times of deliveries, in ways of doing things, in materials, in everything. This is

brought about by studying all aspects of the process using the basic question 'could we do this job more consistently and on targets?' the answering to which drives the search for improvements This significant feature of SPC means that it is not constrained to measuring conformance, and that it is intended to lead to action on processes which are operating within the 'specification' to minimize variability. Conway believes that once a process is in-control, the people responsible for it become more creative in eliminating variations because they know that they are personally capable of improving the system. Control by itself is not sufficient TQM requires that processes should be improved continually by reducing its variability Process control is essential and SPC forms a vital part of the overall TQM strategies. Incapable and inconsistent processes render the best design impotent and make quality assurance impotent. A systematic study of processes through answering the questions, provides knowledge of the process capability.

In application of SPC there is often an emphasis on techniques rather than the implied wider managerial strategies. It is worth repeating that SPC is not only about ***plotting charts on the walls of a plant or office,*** it must become part of the company-wide adoption of TQM and act as the focal point of never-ending improvement. Use of SPC in a company is attributable to reduction in most of the measurable costs.[Benton,1991]

2.2.6 Internal Quality Information

Internal Quality Information is the communication of relevant information about the quality management program. Communication, if properly done and in a planned way, is very effective in influencing attitudes of people. Change in attitudes is required so that TQM can gain the acceptance throughout the organization. For effective communication appropriate method(s) should be selected, the principal ones are:

- Written communication.
- Visual communication.

- Example through the way people conduct themselves.

Written communication is in form of notices, bulletins, news-letters, reports etc and posters, video tapes, exhibitions, demonstrations form the visual communication group. Information regarding cost of quality , feedback of quality data to employees and managers for solving and timely measurement should be quick and on time. Towards this purpose, a Management Information System may be installed to facilitate rapid data transfer organization-wide. In essence, it can be said that for a successful TQM program. It is important to recognize the values and influences of good communication as a vital link in creating and maintaining standards for quality.

2.2.7 Employee Involvement and Empowerment

Years of experience has shown that to implement a conformance based approach, it is necessary to have total participation of all employees in an organization. Involvement and empowerment may be termed as two faces of same coin. It is generally agreed that the Taylor system of scientific management was not able to make use of a huge underemployed asset- the education, experience and creativity of work force and considered as obsolete. Involvement and empowerment is considered as a replacement, still not completely, to the Taylor system. The transfer of tasks from specialists and supervisors to non supervisory workers is labelled as "empowerment" [*Juran*,1988]. Empowerment takes various forms, all of which are going under test. Some usual forms have included, establishing worker self-control[2] and self-inspection[3]. It confers a greater sense of job ownership, and removes the police atmosphere created by use of inspectors.

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[2] Self-control makes it possible for workers to make decisions on the process- decisions such as Is the process in conformance? And Shall the process continue to run or should it stop?

[3] Self-inspection empowers to make decisions on whether the product conforms to the quality goals.

It has become evident that employee involvement adds significantly to companies' quality performance However, certain prerequisites must be met if the participation concepts are to become effective on a continuing basis. Another widely used approach to secure quality improvement is the involvement of employees through suggestion schemes, QC circles and cross functional teams. In suggestion system approach employees are urged to propose improvement of all sorts, including quality related issues. The resulting suggestion may have substantial or minor effects, and range from problem identification to thorough diagnosis and proposing of remedy. Juran contends that suggestion schemes have intrinsic merits because they provide workers with an opportunity in creative activity. QC circles approach forms the key of employee involvement as a part of comprehensive TQM program. A QC circle is a set of volunteers from a group of work-force members who have undergone training for the purpose of solving work-related problems. QC circle activities provide the employees in an organization to participate creatively in matters relating to their own jobs.

Another view of involvement, "participation is a meanes by which intangibles such as morale, sense of belonging and responsibility can be improved"[*Zairi*,1991], suggests that it is important because people, if nurtured in a right way, if provided with right tools, if put in the right work environment, and if given required flexibility to contribute can tirelessly add value to their own tasks and organization' s objectives and can solve various problems via continuous improvement approach.

2.2.8 Employee Training

An essential part of any TQM program lies in magnitude of training imparted to its organization constituents. TQM requires that employees Learn more than simple job

requirements. They must understand the values inherent in the organization' vision, techniques and methods unique to TQM- SPC, Quality circle activities, cross functional teams etc. [Holpp,1989] It is critical that training

- Be delivered on job, with real-world relevance and application time.
- Be delivered as needed, coordinated with the needs of employees.
- Be provided to employees at all levels simultaneously so that clear messages are reinforced all at once.
- Play an active role in need diagnosis, developing and delivering the training

A comprehensive training plan which includes a list of training courses that collectively can meet the training needs of an organization on all dimensions[*Juran*, 1988]. These dimensions cover :

- Fundamental concepts, such as the definition of quality and role of quality in business mission.
- Processes like quality planning, control and improvement.
- Hierarchical levels in an organization.
- Various organization functions, such as marketing, finance.
- Tools and techniques essential for quality .

In TQM programs, organizations become very dependent on teams and teamwork. Most people need to learn to influence each other and those over whom they have little, if any, control. Employees also need to learn how to handle group dynamics so that meetings can be effective. Training programmes can be used to communicate TQM message throughout the organization. As Oakland, (1989) puts it training is the single most important factor in actually improving quality. For training to be effective it must be planned in a systematic manner. Quality training must be on a continuous basis to meet

changes in technology and environment in which an organization operates Planned and systematic approach includes following steps in the given order; specifying quality training needs, preparation of training programmes and materials, implementation and monitoring, and finally assessment of overall effectiveness. It is also important that training should be at all levels and neglect in any of these areas will delay implementation of TQM.

It has been observed that organizations carry out quality training purely as an educational process. For example many managers and supervisors have been trained in quality improvement process but they have not applied the tools to actual job situations. Such practices do not produce the results as expected. Therefore, it is essential that quality related training should be applied to existing processes and jobs within the organization.

2.3 contextual factors

Most of the TQM literature is practitioner oriented which by and large, support the proposition that it can not be affected by contextual variables. Practitioners and consultants consider TQM as one-size-fits-all solution that can be applied irrespective of an organization's characteristics. Juran(1988) states that quality management is "universal" and suggests that the expectations regarding it should be same regardless of the context. Similar views are expressed by Langevin (1977), that expectations regarding quality management should be same in service and manufacturing organization. Rao(1996) stressed that the relative effectiveness of a change program is contingent on the technology, values and strategy of each organization. TQM leads to the changes, and changes are always associated with many factors related to an organization, it can not be

said of a TQM program that it is context-free Since TQM is an organization-wide function, organization theory should be used to describe, explain and improve it. Organization variables may have considerable effect on TQM practices and study of these effects could contribute to improve TQM performance. As Blaw and During(1990), concluded that many organizational characteristics-size, size of parent company, batch size employed, presence of quality department, specialisation and formalization influence various TQM practices Also, several contextual variables such as - role of product/process change, degree of manufacturing content, product's complexity, manufacturing environment, company size, company type (service or manufacturing), and perception of various functions (HR, QA, Purchase, Production etc.) within an organization are reported and their effect on quality management is studied by Benson (1991). Table 2.3.1 contains various contextual factors.

Table 2.3.1 various contextual factors.

Contextual Factors
Product/Process Contextual Variables
Market Place Contextual Variables
Manufacturing Environment
Company Size
Company Type
Number Of Years Since TQM Adoption

TQM may be influenced by following product/process variables (Benson ,1991) :

- rate of product / process change
- degree of manufacturing content

- extent of batch vs continuous process
- product complexity

A high rate of change of product / process design may affect the quality management practices (Garvin, 1983) A low proportion of product purchased outside, a high level of batch content in a process, and high level of product complexity may affect TQM practices as well(Garvin,1983). Lawler(1994) maintains that TQM, with its emphasis on quality improvement, management control, process improvement, work simplification, and recognition rewards, may work particularly well in high-volume, production situations. TQM processes are generally applicable where large number of workers are required to produce a product. or service to a customer.

Market-related contextual variables such as the degree of competition, the extent of barriers to entry in industry and the extent of quality demands by customers may influence TQM. Company size may positively influence TQM implementation since larger companies tend to devote more resources to organized quality programs than smaller ones.(Benson,1991) Size may also be related to complexities of quality systems as larger organizations have multi-layer quality manual. Company type (service and manufacturing) may be expected to influence quality management since the concepts traditionally been applied in manufacturing organizations and have only recently begun to influence service organizations. Manufacturing environment (make-to-order, make-to-stock, and assemble-to-order) may have effect on TQM practices as make-to-stock, and assemble-to-order environments are associated with more highly evolved and more routinized quality management practices than make-to-order environment.

3

Pursuit and Plan of Study

3.1 The Research Objectives

Given the long history of quality management practices in manufacturing area, manufacturer have had a head start in coming to grips with quality problems and opportunities. They, along with their suppliers and customers, have become more knowledgeable and aware of quality issues. As heavy competition and lowering market share was faced by Indian industry after liberalisation they started looking for new avenues. As a consequence they started adopting TQM for their survival. TQM has now become a synonym for success. So our first objective is to know:

- **The extent of TQM aspects as are practised in Indian manufacturing industry.**

Since quality management is an organization-wide function, organization theory should be used to describe, explain and improve it. Quality problems mainly are driven from outside such as customer demand and competitive pressure. The relation of various organizations' context such as nature of product and process, exposure to TQM (long or short), size and manufacturing environment with TQM practices is explored. As its second objective, this study tries to explore:

- **How the contextual factors affect the various TQM aspects in manufacturing industry.**

3.2 Research Questions

Our objective is to see which TQM aspects are affected by contextual variables in a manufacturing industry. Towards this aim we have the following research questions :

- Which TQM aspects are affected by the "number-of-years-of-tqm-implementation" in an organization *i.e.*since when TQM program was implemented
- Which TQM practice are influenced by nature of industry within manufacturing such as electronics, engineering (machinery etc.), process etc.
- How the perception of various functions within an organization vary in relation to TQM practices.
- Which TQM practises are stressed more according to manufacturing environment, for example make to order versus make to stock.
- How size of a company affect the implementation of quality management practices.
- Finally, in general, to what extent the claim regarding implementation of the TQM strategies holds in Indian manufacturing scenario.

3.3 Research Methodology

Research is an exercise full of trade-offs. Good research design should reflect the questions being addressed. Decision regarding subjects of study, data collection procedures, geographical location of subjects and so on are based on the degree of precision, generalizability, and control. High degree of these factors almost always translate into higher costs. Keeping these facts in mind, and after evaluating the strength

and weaknesses of various research designs[1] field survey method was selected Present study covers the manufacturing industry and requires for some generalizability of results over this segment. Case study method is not suitable for our purpose as it is difficult to generalize on the basis of a sample of one or two, also, it is too-time consuming. By keeping in view these considerations, a questionnaire based field survey of manufacturing companies was carried out. Measuring instrument is discussed in questionnaire design section.

As field survey provides economies for doing research (Robbins,1995), it also has a number of potential weaknesses like no opportunity for probe, no control over who fills out the questionnaire, and low response rate (Nachmias & Nachmias,1995). To overcome the disadvantages of questionnaire method it was decided to distribute and collect the responses personally. So it was possible to clarify any doubts about the questionnaire to the respondents. Also it was possible to collect response in a very small span of time saving the precious time.

3.3.1 The Sample

A list of companies enlisted with CII was obtained from CII' Delhi office. From this list, keeping in view the time constraints 20 organizations were approached. Geographical location of companies was the main criterion for their selection. The companies selected for sample are based in New Delhi and Gwalior. The total number of organizations participated are 15. Companies selected were distributed near and around Delhi and Gwalior at Faridabad, Ghaziabad, Noiada and Malanpur.

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[1] Five research design according to Robbins are: case studies, field survey, laboratory experiments, field experiment and aggregate quantitative reviews.

3.3.2 Respondent

TQM is considered having organization- wide impact, therefore, perception and views about it also should be from all constituents of an organization. Since it is not possible to go to everybody, asking he/she to fill the questionnaire, personnel from key positions were selected as respondents. Respondents are selected from different functions- HR, QA, purchase, R&D, Marketing and Production, to cover an organization horizontally. Hierarchy-wise, respondents mainly are from the executive and higher ranks including assistant managers, engineers, senior managers and directors

3.4 Measurement

3.4.1 The Data Collection Instrument

For field survey, a questionnaire was used to measure TQM constructs[1] and contextual variables. Table contains 8 TQM constructs, 5 contextual variables and other details measured by questionnaire. The data collection instrument consisted of two parts· the first solicited respondents' ratings on TQM aspects; the second part asked for the organization's details. In all 44 items were used in questionnaire, 34 for TQM constructs and remaining 10 for contextual and other organizational details. Perception regarding TQM practices sought on five point scale. The five views are; " 1= strongly disagree ", " 2 = disagree ", "3 = neutral", "4 = agree", " 5= strongly agree ". A "CC = can not comment" option was also added to avoid the bias resulting from the unawareness of the respondent. Responses were obtained for the primary product[2] of a company. Complete

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[1] Constructs are latent variables and can not be measured directly.

[2] Primary product is the product generating maximum annual sales revenue.

instrument is given in Appendix -1. Questionnaire was constructed with reference taken from two previous studies, Ahire (1996) and Powell (1995) on TQM implement process Scales used in questionnaire are discussed in next section.

Table 3.4.1 Measured Variables

TQM Constructs	Contextual & Other Variables
• Top Management Commitment	• Size of a company
• Customer Focus	• Quality Department
• Suppliers' Quality Management	• Annual Turnover
• Benchmarking	• Manufacturing Environment
• SPC Usage	• Nunmber of TQM Years
• Internal Quality Information	• Primary Product
• Employee Empowerment & Involvement	• Department & Designation
• Employee Training	• Membership of QC/QIT

3.4.2 Description of Scales

3.4.2.1 Top Management Commitment

It is one of the major determinants of successful TQM implementation. Top management committed to quality must convey the philosophy that will receive a higher priority over cost or schedule, and that in the long -run, superior and consistent quality will lead to improvements in cost and delivery performance. The top management should not only give high priority to quality, but should also demonstrate its quality commitment through by providing adequate resources to implementation of TQM efforts. Following 3

item scale is used to measure extent of committed leadership

1. Clarity of quality goals for organization
2. Relative importance given by top management to quality as a strategic issue.
3. Relative importance given by top management to quality versus cost and allocation of resources to quality improvement efforts

3.4.2.2 Customer Focus

All activities of an organization must be planned and executed to improve processes that lead to manufacturing quality products. However, quality must be incorporated into these activities with a clear customer focus. The pressure to revitalize manufacturing over the last decade has been rooted in customers' demand for a greater variety of reliable products. Customer focus must be reflected in overall planning and execution of quality efforts. Customer focus of an organization is usually assessed by the frequency and rigor of customer satisfaction surveys. However, mere execution of such survey is not useful unless results are communicated to appropriate functions and used for further improvements. Customer focus is measured with following 3 item scale.

1. extent of customer satisfaction surveys' given to managers,
2. availability of customer complaint information,
3. frequency of survey and overall customer focus.

3.4.2.3 Suppliers' Quality Management

The supplier's role is critical in many ways. First, the quality of incoming parts from suppliers determines the level of inspection efforts of a buyer organization. Second, the quality of supplied material, to an extent, determines the final product quality. Third,

supplier' capability to react to a buyer firms' needs, in turn, can determine the buyer's flexibility in responding to the customers' needs. With the objectives of minimizing incoming material inspection and receiving reliable, frequent deliveries through long-term relationships, quality-oriented firms like Xerox and Ford have developed extensive supplier evaluation systems. often, such organizations offer technical assistance to suppliers to ensure consistent superior quality of products. Accordingly, following five item scale represented the profile of an effective Suppliers' quality Management strategy:

1. relative importance placed by the organization on quality of purchased parts versus price,
2. consideration of suppliers' technical capability,
3. consideration of suppliers' financial capability,
4. consideration of delivery performance,
5. emphasis on long-term supplier relationship

3.4.2.4 Benchmarking

Effective management of quality of products and internal processes without losing perspective of the external factors, such as competition, requires judicious use of benchmarking. Benchmarking should, then use this knowledge to improve its own products and processes. The importance of accurate, adequate and timely information on best practices of various processes is acknowledged by leading organizations like Xerox. Benchmarking must be done with a clear focus on the goal of improving quality and reducing cost. Appropriate planning and execution of benchmarking goes a long way in improving processes. Two items were used to measure Benchmarking :

1. Effectiveness of benchmarking in reducing cost of production,

2. Emphasis on benchmarking competitors' products and processes.

3.4.2.5 SPC Usage

To minimize in-production quality problems organizations should have sound design quality planning. However, when products are being produced on the shop floor, variations in manufacturing process variables (such as raw material quality, machine conditions, worker skills, etc) contribute to a variation in product quality. Statistical process control (SPC) techniques are often used to detect assignable causes contributing to the variations in manufacturing quality, to provide useful information for product design, and to determine process capability. A wide range of SPC tools such as scatter diagrams, Pareto charts, cause-effect charts, and control charts are used to monitor quality. To use SPC tools effectively, production workers should have an adequate knowledge regarding their usage. hence, the following scale was used to assess the extent of SPC Usage in organizations:

1. extent of use of SPC in manufacturing,
2. knowledge of production employees in SPC tools,
3. effectiveness of SPC in improving quality of product.

3.4.2.6 Internal Quality Information Usage

While benchmarking allows an organization to look out of window, SPC tools allow it to monitor quality of internal processes. However, both strategies will be rendered ineffective if there is inferior dissemination of the general information. To maintain a true customer focus, an organization must ensure prompt feed back of customer

survey results to appropriate functional areas for effective actions. One of the indicators of the extent to which quality information is shared is the frequency of quality performance data is relayed back to concerned work-stations, cells, and departments Many awards in quality fields also recognize the importance of making timely, adequate and relevant data available to concerned departments and employees These observations led to the following scale for evaluating the effectiveness of Internal Quality Information Usage:

1. visual display of quality information at work stations,
2. visual display of quality performance versus goals,
3. transmittal of defects information to specific work station,
4. availability of scrap data,[1] and
5. availability of rework data[2].

3.4.2.7 Employee Involvement and Empowerment

The focus on quality requires empowering the production workers to inspect their own work and to stop production if the process is out of control. Employee empowerment is essential to improve in-process quality control. Empowerment also leads to increased employee participation. This does not mean only shifting the responsibility for quality decisions to workers, but also entails providing supporting framework such as the necessary resources and technical support, to assist them in decision making. Employee empowerment alone is not adequate to ensure employees' full participation. Employee

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[1] Scrap is defined the wasteful material generated for each good unit produced. It includes defective, unusable units and material remaining after processing of raw material, which may result from poor processes, poor maintenance, etc.

[2] Rework indicates the fraction of total production that must be reprocessed due to nonconformance to specification. Due to repeated efforts on the same units to attain acceptable quality level.

involvement has been found to positively impact employee commitment to quality. The use of cross-functional quality improvements teams and quality circles, along with a framework of approach evaluation and reward systems for quality improvements projects, have been shown to improve quality significantly. Scale for measuring Employee Involvement and Empowerment is as follows:

1. workers authorized to inspect their own work,
2. workers encouraged to find and fix problems,
3. workers given resources to fix problems,
4. technical assistance given to workers for solving problems,
5. extent of quality circle usage,
6. extent of cross-functional teams' usage,
7. extent of employee suggestion implementation,
8. encouragement for employees to give suggestions.

3.4.2.8 Employee Training

Employee empowerment and involvement is not effective unless employees have received formal, systematic training in quality management. Only when employees are trained in quality concepts and tools can they understand the quality -related issues. First and foremost, companies need to view training cost as investments instead of costs. Availability of adequate resources is a prerequisite for an organization-wide training. Participation by various levels of employees and managers in training sessions breaks the barriers between ranks and helps subsequent employee participation. These salient features of employee training are assessed in the following scale:

1. availability of resources for training,

2. frequency of training and retraining an employee,

3 Participation of various levels in training sessions,

4. satisfaction of employees with overall training

3.5 Validity and Reliability of Questionnaire

An instrument of measurement is valid if it measures what it is supposed to measure and reliability is the degree to which the results are consistent. Validity analysis is done by using one or more of the following methods· content validity, convergent validity, discriminant validity and criterion related validity Convergent validity is the extent to which varying approaches to constructs measurement yield the same results. A scale exhibits discriminant validity if its constituents items estimate only one construct. Criterion related validity is a measure of how will scales representing various TQM practices are related to quality performance[Criterion]. An instrument has content validity if its items representatively sample the intended domain of the concept it is intended to measure. To ensure content validity of questionnaire, it was given to three persons at Delhi- a quality consultant, an executive representing the national committee on quality of CII, and a quality manager of a leading company. The questionnaire was modified to incorporate their suggestions. Finally, it was reviewed and verified by a CII's counsellor on quality related matters. Since only one method i. e. questionnaire based survey, was used for data collection convergent validity does not hold for our case. Also, software package limitations did not allow to go for discriminant validity analysis.

Cronbach's alpha is a widely accepted measure of reliability. Typically a scale is said to be reliable if value of alpha is .6 or higher (Ahire, 1996). Table **3.5.1** contains alpha for various scales, it can be seen that all scales are satisfactory on reliability issue.

Table 3.5.1: Scale Reliability Statistics (Cronbach's Alpha)

Construct	Alpha
1. Top Management Commitment	.60
2. Suppliers' quality Management	.66
3. Benchmarking	.91
4. SPC Usage	.88
5. Internal Quality Information	.60
6. Employee Empowerment & Involvement	.77
7. Employee Training	.64

3.6 Process of Data Acquisition

As the first step of data collection, a list of companies was obtained from CII's TQM division. From this list manufacturing organizations implementing TQM were selected, geographical location was the main criterion for their selection. Initially, sample size of 20 was selected. The total number of organizations participated were 15. Companies selected were distributed near Delhi and Gwalior and situated at various industrial areas in Faridabad, Ghaziabad, Noida and Malanpur. Total 15 companies were visited and in all 82 responses were gathered. The list of organizations surveyed with relevant details is given as Appendix-2. In the sample all possible efforts were made to give representation to all constituents within the organization. For this responses were collected from different levels as well as functions. Initially the plan was to collect one response from each department and on average six from an organization. But, during data collection, even two responses were obtained from same department. Table 3.6.1 contains the distribution of respondents across levels and functions.

Table 3.6.1 Respondents' Matrix

Functions ↓ \ Levels→	Top Management	Middle Management	Lower Management	Total
HR	7	5	4	16
QA	1	7	12	20
R & D	2	4	4	10
Purchase	1	5	6	12
Marketing	3	2	6	11
Production	2	2	9	13
Total	16	25	41	**82**

Three levels i. e. top, middle and lower management, were considered. Top management includes personnel from the rank of executive directors and GMs, middle management includes senior managers, engineers and assistant managers were included in lower management. In some organizations there is no independent department for quality, personnel from other functions are looking after quality related activities. Such respondents were considered as representing quality function. In some organizations researcher was referred directly to quality department heads. In some organizations responses were obtained from same function but different levels (HCl-HP, Autometer) while in organizations such as ABB and Usha India, function as well as level both were manipulated. From table 3.6.1 we can see that minimum number of responses are from top management as it is rather difficult to get their time. Maximum responses are from lower level (41) followed by middle(25). QA function (20) has major representation closely followed by human resources (16) department. Responses from other functions are nearly same in number (10-13) into the sample. The data was collected by personal visits of

researcher to every company. In the beginning of data collection, persons mentioned in CII's list were contacted over telephone After getting prior appointment from the person concerned, the plan and purpose of the study was explained. Full confidentiality regarding data was assured. Persons representing various department and positions were suggested as respondents. Appointments were fixed according to mutual convenience. Nearly all respondents were quite co-operative and responsive.

3.7 Choice of Statistical Procedure

Our aim is to see how TQM practices are affected by various contextual factors as discussed in chapter two. This can be seen by the fact that if groups formed on the basis of the contextual variables are analyzed, there should be significant difference among the groups. For statistical analysis purpose, parametric and non-parametric techniques are available. When alternative tests are available for a given research design, it is necessary to employ some rationale for choosing among them.[Siegel,1956]. The considerations for the choice of a statistical test are- power of a test, manner in which the sample was drawn, the kind of measurement or scaling which was employed for measuring the variables. A parametric statistical test is most powerful when all the assumptions of its statistical model are met and when the variables under analysis are measured in an at least interval scale. T test and F test(one- way ANOVA) are widely used parametrical statistical analysis methods. Both test assume that the observations or scores in a sample should have come from a normally distributed population and that the measurement should be al least in an interval scale. In our case, measurement of variables is in ordinal and nominal(classification) level and assumption of normality does not hold, therefore non-parametric

equivalent of F-test is used. For K independent groups, choice of statistical test can be made from among the following available non-parametric methods:

1. Extended Median Test
2. The Kruskal-Wallies (K-W) one-way ANOVA.

The extension of median test and the K-W test may both be applied to the same data, i. e. they have same requirements for the date under test(Siegel, 1956). When the data are such that either test might be use, K-W test will be found to be more efficient because it uses more of the information in the observations. It converts the sores to ranks, whereas the extension of the median test converts them simply to either plus or minuses. Thus the K-W test preserves the magnitude of the scores more fully than does the extension of the median test For this reason it is more sensitive to differences among the k samples of scores. The K-W test seems to be the most efficient of the non parametric tests for k independent samples (Siegel, 1956). Therefore the K-W one way ANOVA is used to see the difference among the groups. Other than this, mean scores for variables related to TQM are obtained to see the extent of attention paid by industry as a whole. A summary of the procedure involved in the K-W test is described now;

- All observations are ranked for *k* groups in a single series, ranks are assigned from 1 to N.
- Value of R (the sum of ranks) for each of *k* group is calculated.
- Use the formula given in equation 3.7.1., to compute the H:

$$H = \frac{12}{N(N+1)} \sum \frac{R^2}{n} - 3(N_{,}+1) \qquad \text{.....(3.7.1)}$$

Where,

N = Total number of ranks,

n = The number of ranks in a group,

R= The sum of the ranks in any column,

H = Statistics distributed as Chi square.

- If the probability associated with the observed value of H is equal to or less than the level of significant, reject H_0 in favour of H_1.

For two independent groups "Mann-Whitney U test" was used to see the difference between groups. This is the one of the most powerful of the non parametric tests, and it is a most useful alternative to the parametric *t* test when assumptions of t test are not met(Siegel, 1956). For fairly large sample sizes n_1 and n_2, the value of U (test statistics) is determined by equation 3.7.2 or 3.7.3.

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1 \qquad (3\ 7.2)$$

$$U = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2 \qquad (3.7.3)$$

Where, where R_1 = sum of the ranks assigned to group whose sample size is n_1, and

R_2 = sum of the ranks assigned to group whose sample size is n_2.

For large samples(n_2 larger than 20) the sampling distribution of U rapidly approaches the normal distribution, with

$$\text{Mean} = \mu_U = \frac{n_1 n_2}{2} \qquad (3.7.4)$$

and, $$\text{Standard Deviation} = \sigma_U = \sqrt{\frac{(n_1)(n_2)(n_1+n_2+1)}{12}} \qquad (3.7.5)$$

That is, when $n_2 > 20$ we may determine the significance of an observed value U by,

$$z = \frac{U - \mu_U}{\sigma_U} = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\frac{(n_1)(n_2)(n_1+n_2+1)}{12}}} \qquad (3.7.6)$$

which is practically normally distributed with zero mean and unit variance(Siegel,1956). The sign of z depends on whether U or U' was used, but the value does not.($U' = n_1 n_2 - U$). Significance level was chosen between .05 and .01 for analysis purpose, as it is general practice.

Further, data is factor analyzed to get a possible framework in which TQM practices can be conveniently put. Factor analysis approach basically is used for data reduction purpose.

4

Data Analysis

4.1 Introduction

As we discussed in previous chapter, one way ANOVA (K-W Test) and factor analysis is performed on the data collected. In all, eight factors critical to TQM were identified from literature, and measured through the perceptions of respondents. Contextual variables are the attributes of an organization. We will use the words strategies, constructs, aspects, factors and variables interchangeably in relation to TQM. In the present chapter sample is analyzed first, followed by analysis of variance for different groups. Factor analysis is done towards the end of the chapter.

4.2 Sample Analysis

The companies selected for sample are based in New Delhi and Gwalior. The geographical location is the main criterion for their selection. Sample size selected was 20. The total number of organizations participated are 15. Companies selected were distributed near Delhi and Gwalior and situated at Faridabad, Ghaziabad, Noida and Malanpur. Total 15 companies were visited and 84 responses were collected from the various functional units of the organizations. These firms represented a cross section of

the manufacturing industry in terms of size, product and process type. Size in terms of number of employees ranges from 180 to 2000 with median value 846 Average annual turnover is Rs. 170 crores, ranging from Rs. 15 to 800 crores. Out of the 15 organizations, 66 7% are using make-to-order, assemble-to-order, make-to-stock, 26% are using only make-to-order environment and only 6% are the process industry. In all 15 organizations average no-of-years-since-TQM-adoption are five, with 55% short term and 45% long term. **(Here short term organizations are where TQM is less than 5 year old and for long term it is more than 5 years)**

In 80% sampled organizations an independent department for quality exists, rest 20% say we do not need a formal quality-department for TQM activities. About 72% respondents are the member of quality-circles and in all organizations union does not exists. Respondents have been drawn from nearly all functions including production, design, marketing, quality, human-resources and purchase.

4.3 One way analysis of variance (ANOVA)

The purpose of ANOVA is to see whether two or more than two groups differ on the variables under consideration. For two groups "Mann-Whitney U test" and for more than two K-W test is used. Here the factor on which basis various groups are formed, is the independent variable and the characteristics for which difference among the groups is observed are dependent variables. In our case, organization attributes are independent variables and TQM constructs are dependent variables. In this section, analysis is carried out for four contextual variables and across the functions:

- Manufacturing environment.
- Size, of the firm.

- Years-since-TQM-adoption.
- Industry type
- Function of the respondents.

Now we analyze them one by one.

4.3.1 Manufacturing Environment

Manufacturing organizations are characterized by one or more of the three environments: make-to-stock, make-to-order and assemble-to-order and some combination of these three. Firms that make to stock are often producing consumer products as opposed to industrial goods. The make-to-stock company produces in batches, and carrying finished goods inventories for most, if not all, of its end items. Make-to-order company, in general, carries no finished good inventory and builds each customer order as needed. This form of production is often necessary when there is a large number of possible end-item configurations, and, thus a small probability of anticipating the needs of a customer. The assemble-to-order firm is typified by an almost limitless number of possible end items configurations, all made from basic components and subassemblies.

This variable is manipulated by forming two groups- first consists of make-to-order firms and the other one includes firms where combination of make-to-order and make-to-stock environment is in use. Size of two subsamples is reported in table 4.3.1.1.

Table 4.3.1.1. Manufacturing environment subgroups.

Group	N
Make-to-order	33
Combination	43

Two groups show significant difference as a result of ANOVA for following three variables.

- Customer Focus
- SPC Usage
- Employee Involvement & Empowerment

The results and statistics are reported in table 4 3.1.2 and table 4 3.1.3.

Table 4.3.1.2 Mean Rank for Manufacturing Environment Groups

Manufacturing Environment → / Variables ↓	Make-to-Order	Combination
Customer Focus.	32.08	42.41
SPC Usage.	30.79	40 35
Employee Involvement & Empowerment	44.68	30.79

Table 4.3.1.3 Statistics and Significance Levels For TQM Practices.

TQM Practices	Z statistics	Significance
Customer Focus.	-2.29	.02
SPC Usage.	-1.94	.05
Employee Involvement & Empowerment	-2.36	.01

From the above two tables it is visible that companies operating in combination environment, show greater degree of customer focus and SPC usage, while make-to-order firms are higher on issue of employee involvement and empowerment. These issues are discussed further in detail.

Customer focus

Environment itself speaks for varying degree of customer focus in two groups. Companies have to asses customer needs, competition in market and other factors to design a product. This situation normally exists in make-to-stock and assemble-to-order manufacturing environment. On the other hand, in make-to-order environment product and processes are designed according to specifications provided by buying company.

Their consumer base and market segment may remain static for considerable long periods. Same is not true where combined environment is in use, reduced product life cycle, and continuously changing customers' expectations force such organizations to be more aggressive to remain competitive

SPC Usage

Processes, in general, are repetitive in nature and more established in combination group than make-to-order. In make-to-order situation it is possible that the processes currently in use may not be needed next time. Addition to existing ones is always possible due to different set of specifications as new order comes. This uncertainty forces an organization to go for "controlling-the-process" option rather than "improve-the-process" alternative in make-to-order environment. It is not that improvement is not there at all, but it is only for a subset of processes which is in use over time, again and again. Due to these characteristics "process manual", a document containing technical information, flow chart, set-up procedures, instruction to operators etc., can be standardized in combination group while in make-to-order addition of a new process into existing ones may result in modification of current manual.

Employee Involvement & Empowerment

Since involvement and empowerment issue involves many dimensions such as suggestion schemes, their implementation and use team based approach for problem solving, it is useful to do ANOVA for every item on the scale to get more in-depth information. From **Table 4.3.1.4,** it has been found that QC circle activities are very common in make-to-order group.

Table 4.3.1.4 Statistics and Significance Levels For Item-Wise ANOVA.

Issue	Z statistics	Significance
Use of QC circle activities.	-2.65	.01

QC circle activities are considered as a way of increasing employee involvement and participation. In make-to-order firms, tasks to be performed are less structured and require greater commitment, skills, mutual and individual accountability to achieve the goals.(such as completion of work as sheduled and satisfied customers) In QC circles a group of volunteers among the workers is formed to do the task efficiently and effectively. Here problems are discussed, suggestions are made and plans are created. Due to relatively less standardized nature of processes in make-to-order firms, QC circles are more evident than combination environment.

4.3.2 Industry

To see how the industry factors affect the TQM practices, responses are grouped in two categories, engineering (machinery, tools etc.) and electronics (computers, semiconductors etc.). Table 4.3.2.1 contains sample size for two groups.

Table 4.3.2.1. Sample Size for engineering and electronics group of companies.

Category	N
Engineering	36
Electronics	22

Two issues are found where views are different, one is benchmarking and other is supplier quality management ANOVA statistics are reported in table 4 3 2 2 & table: 4.3.2.3.

Table 4.3.2.2 Mean Rank for engineering and electronics categories

Industry Type→ / Variables ↓	Engineering	Electronics
Benchmarking	25.93	35.43
Supplier Quality Management.	25.49	34.59

Table 4.3.2.3 Statistics and Significance Levels For TQM Practices.

TQM Practices	Z statistics	Significance
Benchmarking	-2.09	.03
Supplier Quality Management.	-2.02	.04

It can be seen that the electronics firms are giving more attention to benchmarking and supplier quality management practices than engineering firms. These issues are discussed further in detail.

Supplier Quality Management

Out of five items in the scale only item 9 shows significant difference when variance was broken down further. Other items related to suppliers' delivery performance, financial stability, inspection of supplies are found to be comparable in both groups. It may due to the fact that these are traditional approaches in a typical manufacturing firm to manage quality of supplies. Issue of developing a long term relationship with supplier, however, is not present at same level in two groups. ANOVA statistics, as given in **table 4.3.2.4**, show that it is significantly different.

Table 4.3.2.4 Statistics and Significance for Item-Wise ANOVA for Industry

Issue	Z statistics	Significance
Single Sourcing	-1.95	.05

Long term relations with a supplier may be viewed as to generate mutual understanding to improve capability, remove problems, which may generate as a result of hopping from one supplier to another. Efforts towards long term Supplier-relations lead to single sourcing- the development of close relationship with just one supplier for each item. Single sourcing encourages commitment on part of both organizations, supplier as well as buyer. This view is further supported as 60% agree in electronics group while only 41% are for engineering group.

Another face of single sourcing in electronic sector may be that the sources of their supplies are limited while an engineering firm can procure materials and components from many number of sources. Also, in electronics sector manufacturers of components used in various assemblies are bigger than the buyers and sometimes enjoying near monopoly in the market while engineering firms usually receive the supplies from various smaller ancillaries and units. This leads to limited bargaining power of firms manufacturing electronic goods. A case study of Maruti Udyog by Vedpraksh(1997) reveals that the sub assemblies procured from outside may affect the final product quality, double source is used instead of multiple sourcing as to reduce dependency on single supplier. But, it also reports that the efforts toward single sourcing and greater commitment from both sides has just begin and better results are expected in near future.

Benchmarking

In electronics sector introduction of new variants of products and technologies is not uncommon. Pace of innovation is rapid and furious and requires that the processes and practices in industry should be benchmarked. Electronics sector shows better achievements on benchmarking issue Competition may be another cause of increased benchmarking activities. In recent years after deregulation, many new entrants with improved technologies and product attributes started capturing markets in electronics sector. It made existing businesses to incorporate(in some cases to improve) better features through partnerships etc. in to their products This competitive industry environment may be the reason which pushes them to benchmark their products.

4.3.3 YEARS-SINCE-TQM-ADOPTION

On this variable two groups were formed representing short term and long term organizations. Short term ones are where TQM program is less than five years old while for long term, firms having five or more years old TQM program are included. Number of responses in both categories are given in table 4.3.3.1.

Table 4.3.3.1. Sample Size For Short And Long Term Group Of Com panies.

Category	N
Short Term	38
Long Term	44

When TQM constructs were analyzed on the year factor, significant difference was observed on three issues: SPC usage, Internal Quality Information, and Employee Involvement and Empowerment. Relevant statistics are reported in table 4.3.3.2 and 4.3.3.3.

Table 4.3.3.2 Mean Rank for Short And Long Term Categories

TQM -Years→ / Variables ↓	Short Term	Long Term
SPC usage	34.68	43.23
Internal Quality Information	31.91	42.98
Employee Involvement & Empowerment	33.48	47.32

Table 4.3.3.3 Statistics and Significance Levels For TQM Practices.

TQM Practices	Z statistics	Significance
SPC usage	-1.92	.05
Internal Quality Information	-1 98	.04
Employee Involvement & Empowerment.	-2.60	.01

Above tables reveal that the long term firms are better on the three issues. Each issue is analyzed further in the next section.

SPC Usage:

Use of SPC is more pronounced for long-term firms. When further analysis of variance on item-basis is done it is observed that two groups mainly differ on use of Taguchi methods and process capability studies. In long term companies both issues manifest greater extent of use than short term ones. Both are more advanced and sophisticated techniques of controlling and improving the process, short term firms are lacking on these. Item-wise ANOVA statistics are given in table 4.3.3.4.

Table 4.3.3.4 Stat. and Sign Levels For Item-Wise ANOVA for SPC Usage

Issue	Z statistics	Significance
Use of Taguchi methods	-2.19	03
Process Capability Studies	-2.15	.03

Internal Quality Information:

Scale measuring "Internal Quality Information" variable includes the items such as scrap rates, defects, rework rates, display of quality goals and progress towards them. Communication of TQM covers a broad range of activities including face-to-face conversations, videotapes, brochure, booklets, company newsletters, advertising campaigns- anything that talks about the ongoing activities. Item based ANOVA, as reported in table 4.3 3.5, shows that two groups are comparable other than the issues of availability of quality data such as scrap rates and rework rates. Long term firms show better performance by making data available timely and speedily to employees and managers for problem solving and decision-making An advanced Information Management System is needed for fast data travel which may be in place in long term organizations.

Table 4.3.3.5 Stat. and Sig. for Item-Wise ANOVA for Quality Information

Issue	Z statistics	Significance
Availability of rework rates	-2.11	.04

For short term firms 38% respondents disagree while only 25% showed disagreement in long term category on availability of scrap rates.

Employees' Involvement and Empowerment :

Like any other change, TQM takes time to permeate through organizational subsystems. For any change program, on time scale, two stages are critical- understanding and maturity. Companies that are following guidelines and evaluating themselves according to some standard framework such as CII-EXIM Award and ISO 9000 certification criteria,

are "understanding" Companies that have persisted and grown beyond this framework are "mature" ones. Short term organizations are in understanding phase of TQM change program. When ANOVA is performed item-wise, long term organizations show better performance on issues critical to employees' involvement as reported in table 4.3.2.6

Table 4.3.3.6 Stat. and Sig. For Item-Wise ANOVA for Involvement & Empowerment

Issue	Z statistics	Significance
Improved Suggestion Scheme	-2.48	.01
Use Of Cross Functional Teams	-2.36	.02
Implementation Of Suggestions	-1.91	.05
Extent Of Quality Circle Activities	-2.37	02

In relation to TQM major sources of organization resistance are- structural inertia and limited focus of program of change. TQM advocates to breakdown hierarchies, downward delegation of authority, and to create a working environment of the interdependency and teamwork, where people from various functions within the organization work in concert towards attaining goals. Reduced employee's involvement may be due to limited focus of program in short term firms. In long term ones it may be possible that the improvement is not restricted only to one area of organization, but also exists in functions other than production.

4.3.4 Size

Company size (medium, small and large) may influence positively implementation of TQM program.(Bard et al, 1991). Size is one of several dimensions of an organization's context. The following three are important aspects of size that have appeared in literature,

- The physical capacity of an organization.

- ❖ The personnel strength of an organization.
- ❖ Organizational output.

First aspect takes into consideration the amount of physical work an organization can do. *e.g.* number of beds in a hospital, area of land occupied by an facility or organization's unit. The second aspect is number of employees available to do organization's work. It is relevant in sense that it is available for all organizations. Finally, output aspects deals with the organization's achievement in a given period of time, examples may include sales volume etc.

However, the most common measure of size found is "number of employees". According to number of employees two groups were formed; "small to medium" and large size. As indicated in table 4.3.4.1, group one contains 65 responses while 17 responses are from large size firms.

Table 4.3.4.1. Sample Size For "Small to medium" and large Group.

Category	N
Small to Medium	65
Large	17

Employee involvement and empowerment is the main issue on which two groups differ. Relevant statistics are reported in table 4.3.4.2 and 4.3.4.3

Table 4.3.4.2 Mean Rank for "Small to medium" and large Group

Size → / Variables ↓	Small to medium	large
Employee Involvement & Empowerment.	43.97	28.94

Table 4.3.4.3 Statistics and Significance Levels For T • M Practices.

TQM Practices	Z statistics	Significance
Employee Involvement & Empowerment.	-2.30	.02

Employee involvement & empowerment :

Larger firms tend to be more procedural. having more individual resistance in hierarchical structure. It is not so in case of small group organizations where involvement and empowerment, after initiating TQM, becomes a way of getting work done with limited resources. Newall(1991) states that as a company increases in size, the problems associated with the introduction and development of quality program appear to escalate. It has been found that in the larger companies traditional management and working practices are difficult to change, modify and develop in order that they are conducive to the process of quality implementation.

In a case study of a large aluminium plant(Indal Hirakund) on TQM implementation by (Pathak,1997) it is reported that the TQM program was introduced in the year when many of the employees were retiring. It can be inferred that it was done to minimize the resistance which the program otherwise might have faced.

4.3.5 Across Functions

Data was grouped and analyzed across six functions; human resources, QA, R&D, Purchase, Marketing, and Production. Size of subsample for each function is given in table 4.3.5.1.

Table 4.3.5.1. Sample Size For Various Functions.

Functions	N
• HR	16
• QA	20
• R & D	10
• Purchase	12
• Marketing	11
• Production	13

Main issues on which departments differ are: Top Management Commitment, Supplier Quality Management, and Internal Quality Information. Relevant statistics are reported in table 4.3.5.2 and 4.3.5.3

Table 4.3.5.2 Mean Rank for Various Functions.

Functions → / Variables↓	HR	QA	R&d	Purcha	Mkt	Prod
Top Management Commitment	**56.91**	38.11	39 83	30 80	**25.18**	35.17
Supplier Quality Management	41.16	42.55	32.11	**47.80**	**20.65**	37.23
Internal Quality Information	39.00	38 24	42.13	40.55	**18.25**	41.95

Table 4.3.5.3 Statistics and Significance Levels For TQM Practices.

TQM Practices	D.F	Chi-Square statistics	Significance
Top Management Commitment	5	18.19	.01
Supplier Quality Management	5	10.50	.05
Internal Quality Information	5	11.57	.04

From above tables it follows that:

1. HR and purchase, both functions rank higher on top management commitment and supplier quality management issues respectively. Since these two activities are the main responsibility of HR and purchase departments, it is not very surprising.
2. On internal quality information issue nearly all functions are comparable except marketing.
3. Most striking observation is the lowest opinion which marketing function holds on all three variables under consideration.

The marketing function's perception regarding TQM practices is further analyzed. Before going for analysis we should have a look at what marketing, as a part of organization , is responsible for?. Specific duties associated with marketing function are:

- Determination of customer requirements
- Gaining knowledge of competitor's quality performance.
- Setting of product and service specifications.
- Analysis of customer complaints, returns sales staff reports, warranty claims etc.

Top Management Commitment

- This dissatisfaction may be due to the fact that how design function is responding to marketing within the organization structure. Usually design function is located between marketing and operating function. Marketing people discover the needs of customers and design function then translate these specifications into such a form that they are compatible with the operating unit. If any of two entity is not given the required attention which it deserves, growing dissatisfaction is inevitable. Here it seems that marketing has lesser participation and involvement in production planing and development process.
- **Cost perspective** : Total quality is associated with two costs arising out of it- appraisal cost and prevention cost. These cost are no different from any other costs in an organization and resources need to be devoted. Appraisal cost associated with marketing function includes the analysis of degree of acceptance of goods. Similarly, prevention cost includes setting product or service specification correctly. It is possible that adequate resources are not allocated leading to unhappy marketing people.

Supplier Quality Management

Warranty claims many times need replacement of component(s) of sold product. Since such claims are made through marketing department, their inability to meet these

requirements due to inadequate supply of components may be a reason for discontent of marketing function.

Internal Quality Information

This issue deals with the timely availability of data such as rework rates, scrap rates and defect rates. If the data collected from the field by marketing department regarding customers' needs and problems is not communicated to the concerned department in time, increased customer dissatisfaction may result about the services and products of an organization which is not a desired state of affairs from marketing point of view.

4.4 Factor Analysis

Data is further factor analyzed, for components extraction "Principal Component Method" is used and for rotation, "Varimax Rotation Method" is used. Rotation converged in 6 iterations.

Factor loadings of .2 or less are usually regarded as insignificant, loadings of .2 to .3 as low, .3 to .5 as moderate, .5 to .7 as high, and above .7 as very high (Frutcher,1954). **Table 4.4.1** contains the variables with moderate and high loadings after varimax rotation.

Table 4.4.1: Rotated Factor Loadings

	Factor loadings
Factor 1	
• Internal Quality Information	.78
• SPC Usage	.83
• Suppliers' quality Management	.77
• Customer Focus	.41
• Benchmarking	.74

Table 4.4.1: Rotated Factor Loadings (Contd..)

Factor 2	
• Employee Training	.81
• Customer Focus	.61
• Top Management Commitment	.64
Factor 3	
• Employee Empowerment & Involvement	.89
• Top Management Commitment	.50

4.4.1 Interpretation Of Factors

From table 4.4.1 it can be inferred that traditional quality control activities such as SPC usage, communication of quality through posters and banners, customer focus and benchmarking load significantly on factor one, while rather new issues of committed top management, employee involvement, empowerment and training, load on second and third factor.

Table 4.4 2 shows total variance explained by three factors. It can be seen that the extracted factors explain 67.5% of total variance. Since factor one explains 41% of variance it can be inferred that the much attention is still towards the traditional methods of quality control.

Table: 4.4.2 Total variance Explained

Component	% Of Variance	Cumulative Variance
Factor 1	41.00	41.00
Factor 2	15.50	56.50
Factor 3	11.00	67.50

Involvement, empowerment, and employee training practices are still need to be more extensive than present level of existence. When traditional practices will be combined with issues of top management commitment, employee empowerment and involvement, then only it will become TQM in true sense.

5

CONCLUSION

In previous chapter data analysis was carried out by employing ANOVA and factor analysis approach. Contextual variables were used to form groups for analysis purpose. This chapter covers the findings, limitations of study and scope for further research work.

5.1 Research Findings

It has been found that extent of TQM aspects vary with the environs in which a firm operates. Some findings are consistent with established TQM norms and others provide an understanding of the neglected domains of TQM. This study reveals the overall scenario from manufacturing-industry' s perspective It is also observed that some specific TQM approaches have found their wide dissemination in a particular segment of industry. These observation are listed below:

- It has been turned out that "short term organizations", where TQM program is not old enough, are using advanced methods of improving the processes to a lesser degree. Employees' participation in design and planning in "long term organizations" have

have increased through improved suggestion schemes and team approaches along with enhanced communication of quality information within organization.

- Electronic sector firms are found to be more supplier oriented in terms of developing long term relations than engineering ones. Market dominance in components' supplies may be a reason for their dependency on a single supplier. Continuously changing technology and increased competition force electronics firms for intensive benchmarking of better practices in industry
- It has turned out that QC activities are used often as a problem solving tool due to less structured processes in firms operating in make-to-order environment whereas combination group is found to be more customer focused in a sense that expectations and wants of customers are assessed continuously through surveys etc.
- The involvement of all members of an organization is a requirement of company-wide quality improvement. It must involve everyone working together at every interface to achieve perfection. And that can only happen if the management is really committed to quality improvement. Lack of commitment from leadership is clearly evidenced as marketing function is found to be highly dissatisfied when data was analyzed across the functions. This discontent has two probable sources : one is that requirements provided by marketing in terms of unstated expectations held by customers to an extent do not find the inclusion in product design, as it should be. Another source of dissatisfaction is the delay in prompt, clear and accurate feedback of information and customer reaction to the remainder of the organization. This attitude can be made better by using Quality Function Deployment (QFD) to translate needs and expectations as provided by marketing into product design specification and development. QFD is a relatively new technique, which effectively relates "whats" [What customer wants] and "hows" [How

it can be done] of product design. In doing so it translates the voice of customer from marketer' s language. QFD incorporates a significant organizational behaviour component as it includes personnel from engineering, manufacturing, marketing and sales, and acts as a powerful integrative device.

- Overall scenario of TQM in manufacturing sector is not very encouraging. We are still carrying with the traditional practices of quality control. Organizational behaviour aspects like greater participation, extensive training and explicit demonstration of commitment from leaders, which are key to any TQM program are still short of the desired level.

5.2 Limitations of study

A key source of bias may be the selection of respondents. This study measures perception regarding TQM practices from the personnel above the supervisory level. Since supervisors enjoy the unique organizational position, midway between management and workers their inclusion might be resulted in less biased and more representative data. The cross-sectional design of the study is another limitation since it is not measuring pre and post TQM performance measures. Geographical location and absence of comprehensive statistical validity analysis may also result in some bias.

5.3 Scope For Further Work

This study can be extended by including manufacturing as well as service organizations. A causal model relating TQM constructs and an organization' s contexts (both internal and external such as environment, nature of competition, and market share) can be

hypothesized and be tested. Greater validity can be ensured by including criterion variables such as TQM performance, product quality etc. in further study.

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APPENDIX- 1

The data collection instrument consisted of two parts: the first solicited respondents' ratings on TQM aspects; the second part asked for the organization's details. In all 44 items were used in questionnaire, 34 for TQM constructs and remaining 10 for contextual and other organizational details. Perception regarding TQM practices sought on five point scale, " 1= strongly disagree ", " 2 = disagree ", "3 = neutral", " 4 = agree ", " 5= strongly agree " . A "CC = can not comment" option was also added to avoid the bias resulting from the unawareness of the respondent. Responses were obtained for the primary product[1] of acompany.

		SD	DA	N	A	SA	CC
1	Quality goals which "Vision & mission" statements intend to spread, are identifiable by all in the organisation .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
2	In company-wide meetings the quality related issues are discussed regularly.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
3	Adequate resources are allocated toward efforts to improve quality .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
4	To meet customer expectations efforts are put continuously to improve the product.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
5	Quality is also a criterion in selecting supplier of major component.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
6	Supplier's rating-system considers his delivery performance.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
7	Suppliers 'rating-system considers his financial stability .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
8	Quality of supplies is inspected/checked regularly .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
9	We have a system to develop a long term relationship with the suppliers than reducing prices.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
10	We are engaged in benchmarking within industry.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
11	Our benchmarking activities have reduced costs .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

[1] Primary product is the product generating maximum annual sales revenue.

	SD	DA	N	A	SA	CC
12 SPC is used extensively in our firm/plant .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
13 Taguchi methods are used in our organisation	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
14 Process-capability studies are a regular affair.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
15 SPC has been effective in improving the quality of primary** product(s).	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
16 Production supervisors/operators are well trained in SPC.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
17 Scrap rates of our primary product(s)** are readily available.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
18 Rework rates of our primary product(s)** are readily available.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
19 Quality information is displayed at most of the work stations.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
20 Progress towards quality related goals is displayed in our plant .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
21 Information about defects is displayed at the appropriate work stations.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
22 Line workers are encouraged to fix the problems as they find.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
23 Resources necessary to correct quality problems are given to line supervisors/operators.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
24 In design and planning employee involvement has increased.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
25 Employees' suggestion scheme has improved after TQM implementation .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
26 Cross-functional teams are used often .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
27 All employees' suggestions are evaluated .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
28 Most employees' suggestion s are implemented	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
29 There are several quality circles in our plant .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

	SD	DA	N	A	SA	CC
30 Resources are available for employees' quality training .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
31 There is almost always some kind of quality training program going on .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
32 Plant managers are often involved in quality training .	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
33 Most employees in our plant are trained to use quality problem solving techniques.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
34 Most employees in our plant do not view each new quality seminar or training program as " just another fad ".	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

SECTION -2

Information regarding variance organizational contextual factors was obtained through the following items.

1. Year of company's incorporation.
2. Size of firm/unit/company (in terms of number of employees) where TQM is currently under implementation.
3. The number of years since TQM started off in the firm/unit/organisation.
4. Manufacturing technology used by company.
5. Whether an independent department looking after quality exists in our plant/company.
6. Annual Turnover.
7. Primary product of the company
8. Department of the respondent.

9. Designation of the respondent.

10. Whether respondent is the member of any quality circle/ quality improvement team.

Appendix-2

A list of organizations covered in the study is in the table below :

Organization	Environment	TQM Years	Size (In terms of emps.)	Turnover (In Crores)	Product Type
A B B	Combination	6 0	180	30	Induction Motor
Autometers	Combination	4 0	180	14	Relays
Eicher	Combination	7 0	800	300	Tractor
Godrej	Combination	4 0	480	120	Soap
Hcl-Hp	Combination	3 0	2200	800	PCs
Jamna Auto	Make to order	5 0	500	80	Leaf Spring
Modi Xerox	Combination	10	1800	463	Plain Copier
Parisudh Sadhan	Make to order	7 0	275	15	Milling machines
Roto Pumps	Make to order	3 0	500	16	Pumps
Samtel Electronics	Combination	7.0	746	80	C P T
Sri Ram Fabric	Make to order	4 0	511	50	Yarn
Sri Ram Piston	Combination	5 0	2000	175	Piston rod
Steel Strips	Combination	3.0	200	40	Steel Rims
Usha India	Make to order	4.0	630	30	Semi Conductor
Vam Organic	Combination	4 0	1700	350	Vinyle Acetate